ACTIVITY 7

INVENTING A MONITOR

This activity lets students brainstorm and problem-solve to find methods for collecting particulates as a first step in finding what pollutants may be in their classroom or outdoors. It is related to the "Where's That Odor?" warm-up. Related activities include "Breathing Room," "Finding Sources of Air Pollution," and "Is Your Air Clean?"

CRITICAL OBJECTIVES

- Explain the importance of monitoring air pollution
- Describe various methods that could be used to monitor air pollution
- Participate in problem-solving to determine the most effective method for particulate matter (as an example)

SKILLS

- Defining problems
- Comparing ideas
- Drawing conclusions

GUEST PRESENTERS

Guest presenters could include air quality engineers, environmental scientists, EPA air quality monitoring specialists, state or local air quality managers, or toxicologists. (Give preference to presenters who can display and describe some monitoring equipment for particulates).

BACKGROUND

Air pollution is caused by many types of contaminants, including chemicals, microorganisms, and particulate matter. Particulate matter includes visible and invisible particles of liquids and solids, including dust, smoke, and other matter carried in the air. Particulate matter containing acids (dry deposition) can deteriorate buildings and other structures. Particulate matter larger than about ten micrometers (microns) in diameter is filtered out in the nose or caught by mucus in the respiratory tract and propelled up to the throat by tiny hairs (cilia). Although the cilia can be damaged by air pollutants, the particulate matter below ten microns (PM-10) in diameter is of greatest concern to human health, because it is not filtered and thus reaches the critical areas of the lungs where oxygen exchange takes place and where there are no cilia or mucus to remove it. (See reading material on "Air Pollution.")

RELATED WARM-UP
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REFER TO READING MATERIAL
"Air Pollution"

TARGET GRADE LEVEL
6th - 12th

DURATION
45 minutes

VOCABULARY
Carbon monoxide
Cilia
Lead
Micrometer (micron)
Monitoring
Mucus
Nitrogen oxides
Ozone
Particulate matter
Sulphur dioxide
Toxic Release Inventory

MATERIALS
Chalkboard
Chalk
Monitoring equipment (if available)
Paper
Pencils

The most common source of PM-10 and other suspended particles in air is smoke from commercial and industrial combustion sources, forest fires, burning leaves, fireplaces, wood stoves, diesel engines, and poorly maintained motor vehicles. Dust is another important source of particulate matter. Wind storms carry dust and fine sand. Farmland, when plowed or left exposed to wind, construction sites of all kinds (including highway sites), and logging and mining operations are major sources of dust.

WHAT TO DO

1. Explain the importance of monitoring to determine if air pollutants are being released. The air around us is more polluted than ever before, and with the increasing number of pollution sources, especially in urban and industrialized areas, reducing the risks to human health and the environment presents a major challenge to society. In order to design and evaluate pollution reduction programs, it is necessary to determine which air pollutants are reaching harmful levels. An extensive monitoring and emissions tracking program is in place for ambient carbon monoxide, lead, nitrous oxides, sulphur dioxide, ozone, and PM-10, but there is no similar program for the emissions of 189 hazardous air pollutants considered toxic to people. The EPA's Toxic Release Inventory (TRI) is currently the only database available for assessing trends in emissions of these air toxics. The TRI requires certain facilities emitting above specified quantities of air toxics to submit annual reports to EPA on their releases. Some non-manufacturing facilities such as mining, electric utilities, and mobile sources are not required to report. Monitoring equipment generally is expensive and difficult to maintain. Consequently, cost-effective air monitoring devices are needed.

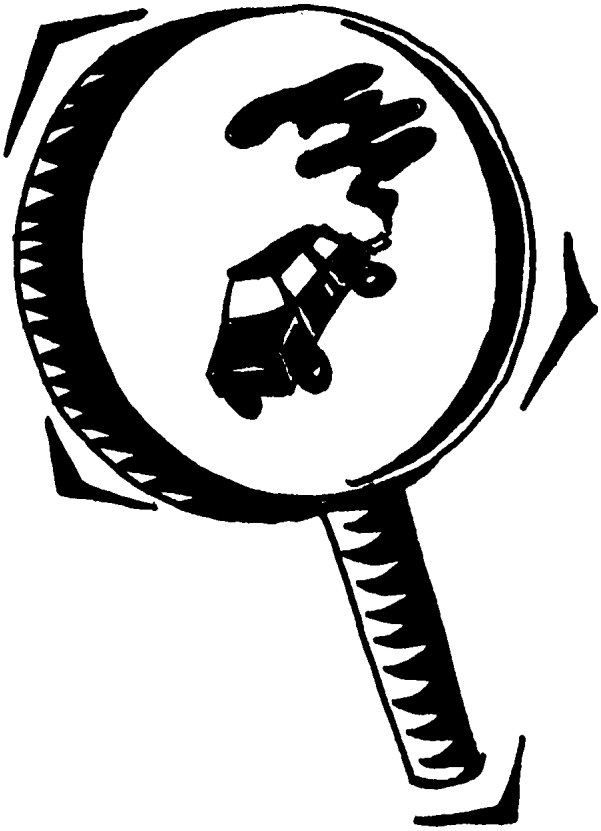
2. Explain that for the purposes of this activity students are to assume they have to design a monitoring device to collect particulate matter (PM) in the air in this classroom. Ask what would be their first step? Remember, many pollutants cannot be easily seen or smelled. If necessary, prompt the discussion with some of the following questions:
   What kind of particulate matter is likely to be in the classroom—smoke, dust?
   How is it likely to enter the classroom air—via the ventilation system, windows, peoples' clothing?
   Is there likely to be more than one type of particulate matter in the classroom air?
   Would it be necessary to monitor them all, or would monitoring one be adequate to draw conclusions about the others?
   Could molds, bacteria, and other pollutants affect monitoring results?
   Could the humidity (high or low) of the air in the room affect the accuracy of the results?
   Would it be necessary to control the movement of air through the room? If so, how would you do it?

3. Help students brainstorm different ideas for collecting particulates (for example, filters, collection dishes, electrostatic materials). Record their ideas on the chalkboard. Encourage students to explain how and why their suggestions would work. (Their suggested designs should show consideration of the size of the particulate matter they are trying to monitor, how to eliminate bogus materials, and how the particulate matter collected in the monitor could be measured—for example, with a microscope, by washing and counting electronically, or through chemical analysis.)

4. Poll the rest of the class to see if they agree or disagree with each suggestion. Ask them to explain why. When you have elicited two or three good, supportable alternatives, ask the class to choose the best one and ask several to explain their choices.

5. When some consensus has been reached on the best method for collecting particulates, ask if one of the chosen monitoring devices will be sufficient to get accurate results. What would be the advantage, if any, in locating monitors in several locations around the classroom? Record students' answers on the chalkboard.

6. Have students draw the outline of the classroom on a sheet of paper. Instruct them to mark the locations of the classroom's doors and windows. Assuming they would use the monitor chosen by the class, have students mark on this "map" where they think the device, or devices, should be placed to ensure the best results. When the activity is completed, encourage students to share their suggestions and explain why. (You may want to draw a classroom "map" on the chalkboard for students to use in presenting their ideas.)



7. Have students discuss the alternatives presented and choose the best one. Suggest that accurate monitoring only yields part of the answer to what is in the air.

8. Help the students examine what they can do to reduce particulate air pollution in their classroom. If necessary, prompt the discussion by asking the following questions:
What factors influence the quality of the air in the classroom? For example, what kinds of pollutants do humans generate? Which of those do we bring into the indoor environment? Can all of these pollutants be measured? Can you or the school change any of those factors?

9. Record answers on the chalkboard. (Make sure the following suggestions are brought out in the discussion: Change the filters in the ventilation system; clean the ventilation system regularly; close the windows on high smog days (not relevant for many schools with sealed windows); increase the air humidity.

SUGGESTED EXTENSIONS (OPTIONAL)

☼ If a light microscope is available and the classroom has an electronic device like a computer or television that is used often, place a glass slide on the electronic device (for example, on top of the computer monitor) for at least three days before the lesson. (Electronic devices tend to attract particulates.) During the lesson, examine the slide under the microscope, and discuss the magnification limits of the microscope.

SUGGESTED READING

Gutnik, Martin J. *The Challenge of Clean Air*. Hillside, NJ: Enslow Company (1990).